Remarks/Arguments

This Amendment is being filed in connection with Applicants' Request for Continued Examination. Reexamination and reconsideration of the application, as amended herein is respectfully requested.

Claims 1-8, 12 and 13 remain in the application. Claims 9-11 are withdrawn from consideration. Claims 1 and 12 have been corrected at line 6 of each claim to include the word "of" after "material" to overcome the Examiner's objection in the Office Action of December 19, 2003.

Applicants note that in the Office Action of December 19, 2003, the Examiner remarked that Applicants' argument of utilizing an inductive sensor via the use of a "metallic holding form" was drawn to a newly presented claim limitation not previously presented. Accordingly, the Examiner went on to rely upon Takahashi (US 4,870,359) or, in the alternative, Takahashi in view of JP 58-123402. Applicant understands the Examiner's point with respect to the newly cited references. Applicants note that there are now rather basic and clear distinctions between the claims as proposed herein and the art as currently applied, and respectfully believes that the application, as amended herein, is in condition for allowance.

As an initial matter, claims 1 and 12 have been amended to deal with a clerical matter, noted above, and to clarify that the present invention is directed at the feature of "providing an automotive trim panel material having a known shape, <u>an outer surface and an inner surface defining a thickness of between 0.001 – 0.500 inches</u>, and a region in which the thickness of said trim panel material may be measured." This amendment is fully supported by the specification, and attention is directed to page 6, lines 8-17, which recites that the sensor of the present invention provides thickness determinations between 0.001" – 0.500" and at all ranges therebetween at reducing thickness values of 0.001". In addition, the amendment here includes reference to the use of polymeric material, and attention is directed to page 3, lines 1-3, which makes clear that the present invention was indeed directed to the detection of part thickness in

non-metallic/polymeric type materials.

Furthermore, independent claims 1 and 12 have been amended to emphasize that the inductive sensor herein is a shielded inductive sensor, which refers to the fact that the sensor contains a metallic band to direct the electromagnetic field to the front of the sensor. Support can be found at page 5, lines 8-11 which defines the inductive sensor as being made by OMRON, Model E2CA-X2A. Along those lines enclosed is the Omron product brochure for the "E2CA" which makes clear at page 79 that the "E2CA-X2A" is a shielded sensor. Accordingly, no new matter is believed entered by this amendment.

In the Final Office Action, the Examiner rejected claims 1-2 under 35 U.S.C. 102(b) as being anticipated by Takahashi (United States Patent No. 4,870,359), or in the alternative, under 35 USC 103(a) as obvious over Takahashi ('359) in view of JP 58-123402. Applicant responds as follows.

With respect to the 35 USC 102(b) rejection, the Examiner stated in part as follows:

> "Takahashi ('359) teach the claimed process for measuring the thickness of a non-metallic material (plastic) including, providing a molded non metallic material (1), interposing said molded non-metallic material between a metallic mold (2) holding said molded non-metallic material (see col. 2, lines 35-40)(holding form having essentially the same shape as at least a portion of said trim panel material [of] known shape where the portion of the holding form which corresponds to the region of the trim panel material to be measured is metallic)..."

Applicants pause to note that the Examiner's suggestion that Takahashi teaches anything whatsoever with respect to the use of a holding form having essentially the same shape as at least a portion of a trim panel of known shape, where the portion of the holding form which corresponds to the region of the trim panel material to be measured being metallic, is simply not the case. Applicants disagree that one can take Takahashi's disclosure for "holding said molded non-metallic material" and suggest that such teaches, or somehow inherently suggests, a process

for measuring the thickness of an automotive trim panel material.[1] Quite simply, nowhere, up and down the entirety of Takahashi '359, is there even a hint that the apparatus therein has anything to do with the process of measuring and recording the thickness of an automotive trim panel. Nor does Takahashi therefore disclose or teach anything regarding the use of a holding form that would have the same shape of at least a portion of a trim panel.

In addition, similar comments apply to JP 58-123402. JP 58-123402 makes clear that it is directed at the measurement of various thickness of tubular insulating layers covering a conductor having a circular cross section, by making the value of W/H of the shape of the iron core of a displacement measurement device at least 1.5. With such critical feature, apparently necessitated by the fact that JP 58-123402 is directed at tubular insulating layers, the tubular insulating layer 22 is measured which contains a corresponding tubular conductor 21. Accordingly, JP 58-123402 does not teach or suggest anything regarding the process of measuring and recording the thickness of an automotive trim panel, and the comments distinguishing Takahashi above are just as suitable with respect to JP 58-123402.

The above being the case, Applicants respectfully request that the Examiner's rejection under 35 USC 102/103 in view of Takahashi (U.S. 4,870,359) and JP 58-123402 be withdrawn. In addition, it is worth noting, as mentioned in the above footnote, that although Applicants have amended the claims herein to better clarify the invention, it is also respectfully noted that the rejection under 35 USC 102/103 in view of Takahashi and JP 58-123402 did not hold up even

[1] For one to find that Takahashi "inherently" teaches a process for measuring and recording the thickness of an automotive trim panel, wherein one, among other things, provides a holding form have essentially the same shape as at least a portion of the trim panel, one would need to demonstrate that such feature would be necessarily present in Takahashi, and that it would be recognized by one of ordinary skill in the art, mindful of the requirement that it is not sufficient to simply suggest that it "*may*" result from Takahashi. *Continental Can Company v. Continental Pet Technologies*, 948 F. 2d 1264 (Fed. Cir). Again, nothing in Takahashi can be found that shows that the device therein would be one that "inherently" provides the features of claim 1, prior to the instant amendments, and certainly in view of the instant amendments.

prior to the amendments proposed herein. The limitations of the claims noted above that are simply not disclosed or suggested by Takahashi existed before the instant proposed amendments.

This then of course raises the principal question as to whether the primary reference of Takahashi, in combination with Bauer et al (US 6,294,124) and GB 2 217 835, continues to support a rejection under 35 USC 103. In addition, Applicants note that the Examiner also separately rejected dependent claim 6, and in addition to the above references, referred to GB 2 035 566. In view of the amendments herein, and the remarks below, Applicants respectfully submit that the 35 USC 103 rejection has been traversed.

Takahashi ('359) is directed at measuring the thickness of a ceramic green molded body **of tubular shape** with a closed end by "filling" the tubular shape with metal and **contacting the outer surface** with a measuring probe, utilizing **an electromagnetic combination of an alternating magnetic field generated by said probe with said metal.** JP 58-123402 is directed at measuring **tubular insulating layers covering a conductor having a circular cross-section** by sliding a measuring element having an iron core along the insulating layer. **The iron core generates a magnetic flux which may be correlated to the thickness of the insulating layer.** It should be noted that both of these references are directed at measuring **tubular objects from the outside** using **electromagnetics (magnetic field).**

Furthermore, with regards to the principal reference of Takahashi, attention is drawn to the fact that at column 4, line 64 through column 5, line 6, Takahashi makes clear that the invention therein was limited to measurement of thickness in the range of 0 mm to 3 mm. Indeed, Takahashi invites the reader to a consideration of FIG. 3, wherein it is emphasized that with respect to the technology therein, a linear relationship between voltage and thickness could only be established, for his "zirconia green molded body **8"**, and that the voltage response above

3.0 mm was non-linear, and understandably unreliable for thickness determinations above this value. Converting this to inches, Takahashi therefore teaches that with respect to his ceramic "zirconia green molded body", one can measure a thickness between 0.00 – 0.12 inches, and that beyond such thickness values, the system would not provide useful thickness measurements.

The invention herein has been amended to recite that it is directed at measuring a polymeric material typically in the shape of an instrument panel as well as other soft trim for a motor vehicle. This excludes the primary reference of Takahashi, who is concerned with measuring thicknesses of ceramics. In addition, completely contrary to the principal reference of Takahashi, the invention herein recites and claims the ability to measure thickness of polymeric material in the range of 0.001 – 0.500 inches. This then represents not only a different material than that disclosed by Takahashi, it recites a range that Takahashi unambiguously defined as not being possible to accomplish.

Furthermore, while perhaps not immediately apparently, the present invention is directed at the use of a shielded inductive sensors. In addition, the trim panels to which such inductive sensors may be applied are typically of complex shape and protrude towards the occupant in the vehicle. Thus, the backside or inner surface of the material thus formed is concave in shape. This is particularly the case when a tear seam will be cut in the backside of a skin following measurement of the thickness in a specific area. Accordingly, the slush molds used as described in the invention are "bowl-shaped" to contain the liquid or powder used to form the polymeric material.

Accordingly, electromagnetic devices as described in the cited art do not appear to have been exploited to measure the thickness of such concave or bowl-shaped polymeric articles since the walls of the bowl would likely interfere with the magnetic field as one tries to measure the

thickness in an area near the edge or walls of the bowl. The field emanating from the measuring device would typically encounter the metal surface directly beneath the sensor as well as encountering the metal wall in close proximity along the side of the sensor and will not be able to distinguish clearly between them. Thus, the use of the shielded inductive sensors as disclosed and claimed herein have not been employed to measure the thicknesses of concave or bowl-shaped polymeric articles, of the dimensions now recited.[2]

Claims 1-5, 7-8 and 12-13 are rejected under 35 USC 103(a) as being unpatentable over Bauer,et.al. (US Patent 6,294,124B1) in view of Takahashi ('359) and in further view of GB 2 2217 835. As the Examiner points out on page 5 of the Final Office Action mailed December 19, 2003 "Bauer, et al does **not** teach an inductive measurement system". Applicants agree and add that Takahashi ('359) discloses a system (electromagnetic) that is not suitable for measuring the thickness of an automotive trim panel from the backside, as noted above.

Use of the apparatus disclosed in GB 2 035 566 would also not be practical in view of Bauer, et al. ('124) since access to the opposite side of the trim piece cover layer **16** would not be possible (see FIGS. 1, 3, 4 and 4A of '124) as the cover layer has to be placed into a form to position the layer for accurate scoring by the laser.

Regarding GB 2 217 835, the reference discloses the use of an eddy current gauge to

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[2] In that context, Applicants do not agree with the Examiner's proposition that laser, ultrasonic and inductive systems are all equivalent alternatives that are used in measuring thickness of non-metallic materials, as suggested at page 6 of the Office Action of December 19, 2003. In fact, GB 2 217 835 actually distinguishes between the different techniques, when noting that in the case of measuring thickness via radiation, one must take into consideration the absorption coefficient of the radiation. With respect to ultrasonic or laser, GB 2 217 835 emphasizes that such devices require "rigid frames" in order to carry the measuring devices as distortions in the position of these devices generate errors in the calculated thickness measurement. Then GB 2 217 835 goes on to emphasize that it sought to overcome the various disadvantages of the known thickness measuring devices, and ultimately emphasizes a radiation device that requires a sensor for reflection and a second measuring device to determine what GB 2 217 835 describes as a "reference point or level". It is therefore not believed that GB 2 217 835 levels the playing field with regards to thickness measurement devices and equates them as all being, as suggested by the Examiner, "equivalent alternatives".

determine the position of a reference point or level (metal bed) (see claim 1) relative to the measuring device and requires a second "radiation type measuring device to measure the distance to a first surface of the object". Applicants accomplish measuring in a single step with a single sensor without the need for the subtractive step emphasized in GB 2 217 835 at page 2, lines 12-17 ("[i]n this type of arrangement the evaluation of thickness involves a subtraction step in which a distance measured by the first device is subtracted from a distance measured by the second device so that the effects of any distortion in the structure of the device tend to cancel each other out").

Taking GB 2 035 566 in view of Bauer, et al. it would not be possible to manipulate a moving ball and magnet along a polymeric material which may, upon occasion, require nearly full support for measurement and scoring. Or, stated another way, it is not believed that Bauer and GB 2 035 566 are properly combinable to form the present invention and the inclusion of the principal Takahashi invention (ignoring for one moment that Takahashi actually teaches away from attempting thickness measurements at the range now cited) would provide inaccurate data.

In consideration of the amendments to the claims and the remarks hereinabove, Applicants respectfully submit that all claims currently pending in the application are believed to be in accordance for examination. Reexamination and reconsideration is requested. Allowance at an early date is respectfully solicited.

In the event the Examiner, Dr. Staicovici, deems that personal contact is necessary, please contact the undersigned attorney at (603) 668-6560. The undersigned would be more than happy to discuss any aspects of the invention and directly consider any concerns of the Examiner.

In the event there are any deficiencies or additional fees are payable, please charge then (or credit any overpayment) to our Deposit Account No. 50-2121.

Respectfully submitted,

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CERTIFICATE OF MAILING

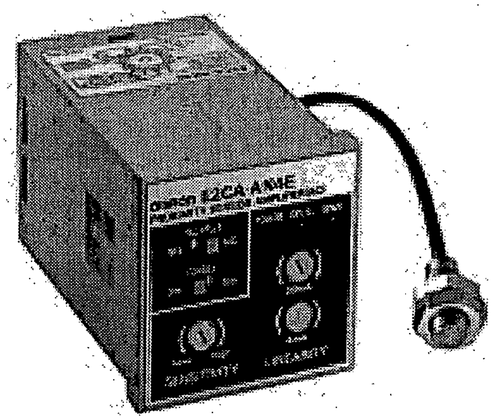
I hereby certify that this correspondence is being deposited with the United States Postal Service First Class Mail in an envelope addressed to: MAIL STOP AFTER FINAL, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on March 16, 2004, at Manchester, New Hampshire.

By: Carol McClelland
Carol McClelland

Special-Purpose Proximity Sensor | E2CA

Threaded Cylindrical Inductive Sensor with Separate Amplifier Provides Precision Linear Analog Output and a Discrimination Output

- Linear 4 to 20 mA output for target to sensor distance
- Position measurements accurate to ±0.0006 mm with 0.05% full scale resolution
- Adjustable setpoint controls switching output rated 100 mA is NO/NC selectable
- Amplifier has power ON, target detected, and discrimination output indicators
- AC amplifier has universal voltage rating 90 to 264 VAC
- DC amplifier rated 10 to 30 VDC
- Sensors available in standard 8, 12, 18, 30 mm sizes with sensing distances up to 10 mm



Sensing	Supply voltage	Output	
1.5, 2, 5, 10 mm	90 to 264 VAC, 50/60 Hz amplifier or 10 to 30 VDC amplifier	4 to 20 mA	100 mA, 40 VDC

Ordering Information

■ SENSOR

Sensor type		Shielded			
Part number	3 m (9.8 ft) cable	E2CA-X1R5A	E2CA-X2A	E2CA-X5A	E2CA-X10A
	5 m (16.4 ft) cable	E2CA-X1R5A-5M	E2CA-X2A-5M	E2CA-X5A-5M	E2CA-X10A-5M
Size		M8	M12	M18	M30
Nominal sensing distance		0.3 to 1.5 mm (0.01 to 0.06 in)	0.4 to 2.0 mm (0.02 to 0.08 in)	1 to 5 mm (0.04 to 0.20 in)	2 to 10 mm (0.08 to 0.39 in)

■ AMPLIFIER

Required sensor		E2CA-X1R5A/-5M	E2CA-X2A/-5M	E2CA-X5A/-5M	E2CA-X10A/-5M
Part number	AC power supply	E2CA-AN4C	E2CA-AN4D	E2CA-AN4E	E2CA-AN4F
	DC power supply	E2CA-AL4C	E2CA-AL4D	E2CA-AL4E	E2CA-AL4F
Outputs		Linear output, 4 to 20 mA; Switching output, selectable NO or NC transistor			

■ ACCESSORIES

Description		Part number
Mounting brackets for sensors	Fits M8 size sensors	Y92E-B8
	Fits M12 size sensors	Y92E-B12
	Fits M18 size sensors	Y92E-B18
	Fits M30 size sensors	Y92E-B30
Sockets for amplifiers	Combination bottom surface and track mounting socket with screw terminals	P2CF-11
	Back mounting socket with screw terminals for panel mount applications	P3GA-11
	Circuit board socket with solder terminals	PL-11

(This table continues on the following page.)

Specifications Table — continued from previous page

Description		Part number
Panel mounting adapter for amplifier		**Y92F-30**
Protective covers for amplifier	Hard plastic cover protects amplifiers from dust, dirt and water drip	**Y92A-48**
	Soft plastic cover protects amplifier from dust, dirt and water drip	**Y92A-48D**
Mounting track	DIN rail, 50 cm (1.64 ft) length	**PFP-50N**
	DIN rail, 1 m (3.28 ft) length	**PFP-100N**
	End plate	**PFP-M**
	Spacer	**PFP-S**

■ REPLACEMENT PARTS

Description		Part number
Mounting hardware includes one pair of metal nuts and washers	Fits M8 size sensors (supplied with each sensor)	**M8-MHWS**
	Fits M12 size sensors (supplied with each sensor)	**M12-MHWS**
	Fits M18 size sensors (supplied with each sensor)	**M18-MHWS**
	Fits M30 size sensors (supplied with each sensor)	**M30-MHWS**

Specifications

■ SENSOR

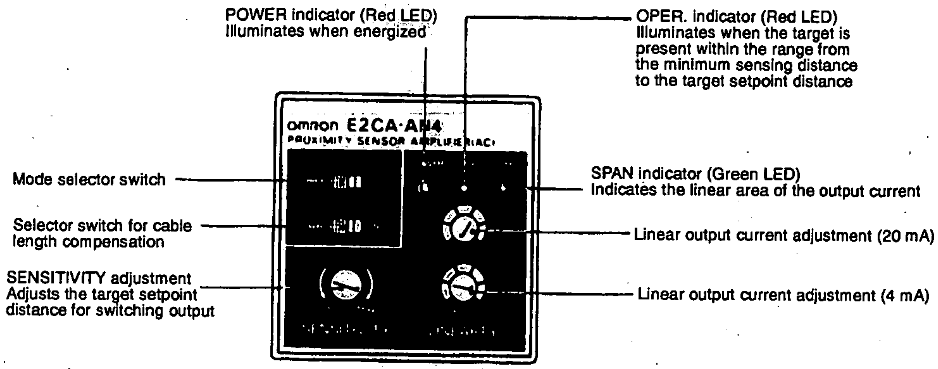
Part number		E2CA-X1R5A/-5M	E2CA-X2A/-5M	E2CA-X5A/-5M	E2CA-X10A/-5M
Sensor type		Inductive			
Body	Size	M8	M12	M18	M30
	Type	Shielded			
Required amplifier		E2CA-AL4C or E2CA-AN4C	E2CA-AL4D or E2CA-AN4D	E2CA-AL4E or E2CA-AN4E	E2CA-AL4F or E2CA-AN4F
Detectable object type		Metallic objects			
Effective maximum sensing distance (with standard target)		1.5 mm (0.06 in)	2 mm (0.08 in)	5 mm (0.20 in)	10 mm (0.39 in)
Usable sensing range (with standard target)		0.3 to 1.5 mm (0.01 to 0.06 in)	0.4 to 2.0 mm (0.02 to 0.08 in)	1 to 5 mm (0.04 to 0.20 in)	2 to 10 mm (0.08 to 0.39 in)
Standard target size (mild steel, L x W x H)		8 x 8 x 1 mm (0.32 x 0.32 x 0.04 in)	12 x 12 x 1 mm (0.47 x 0.47 x 0.04 in)	18 x 18 x 1 mm (0.71 x 0.71 x 0.04 in)	30 x 30 x 1 mm (1.18 x 1.18 x 0.04 in)
Response frequency		10 kHz		5 kHz	3 kHz
Indicators		Not provided			
Materials	Housing	Nickel-plated brass			
	Sensing face	Plastic, acrylonitoryl butadiene styrene			
	Cable sheath	Plastic, polyethylene			
Mounting		Two lock washers and M8 nuts included. Bracket Y92E-B8 optional.	Two lock washers and M12 nuts included. Bracket Y92E-B12 optional.	Two lock washers and M18 nuts included. Bracket Y92E-B18 optional.	Two lock washers and M30 nuts included. Bracket Y92E-B30 optional.
Connections	Prewired	2-conductor shielded cable: 3 m (9.8 ft) length (E2CA-X☐☐☐A) 5 m (16.4 ft) length (E2CA-X☐☐☐A-5M)			
Weight with cable		40 g (1.4 oz.)	60 g (2.1 oz.)	140 g (5.0 oz.)	160 g (5.7 oz.)
Enclosure ratings	UL	—			
	NEMA	1, 4, 6, 12, 13			
	IEC 144	IP67			
Approvals	UL	—			
	CSA	—			
Ambient operating temperature		-25° to 70°C (-13° to 158° F)			-10° to 55°C (14° to 131°F)
Vibration		10 to 55 Hz, 1.5 mm (0.06 in) double amplitude			10 to 25 Hz, 2 mm (0.08 in) double amplitude
Shock		Approx. 50 G			Approx. 10 G

■ AMPLIFIER

Part number			E2CA-A□4C	E2CA-A□4D	E2CA-A□4E	E2CA-A□4F
Supply voltage	AC types		90 to 264 VAC, 50/60 Hz (E2CA-AN4□)			
	DC types		10 to 30 VDC (E2CA-AL4□)			
Current consumption	AC types		60 mA max. (E2CA-AN4□)			
	DC types		70 mA max. (E2CA-AL4□)			
Required sensor			E2CA-X1R5A	E2CA-X2A	E2CA-X5A	E2CA-X10A
Linear output characteristics	Output range		4 to 20 mA			
	Resolution		0.05% to full scale			
	Linearity		± 2.0% of full scale	± 1.5% of full scale		± 2.0% of full scale
	Response frequency		10 kHz		5 kHz	3 kHz
	Adjustment	4 mA	Adjustment to 4 mA at 20% of effective maximum detecting distance			
		20 mA	Adjustment to 20 mA at effective maximum detecting distance			
Switching output characteristics	Operation mode		NO or NC, switch selectable			
	Detecting distance sensitivity		Adjustable (within sensor's "Usable Detecting Range")			
	Differential travel		Fixed, 1 to 5% of detecting distance			
	Control output	Type	Transistor, SPST			
		Max. load	100 mA, 40 VDC			
		Max. on-state voltage drop	2 VDC			
	Response frequency		3 kHz		1.5 kHz	1 kHz
Circuit protection	Switching output short-circuit		Not provided			
	DC power supply reverse polarity		Provided			
	Weld-field immunity		Not provided			
	RFI immunity		Not provided			
Indicators			Power ON (POWER), Linear Range (SPAN), and Switching Output ON (OPER)			
Materials	Housing		Plastic			
Mounting			Requires P2CF-11, P3GA-11 or PL11 sockets (not included); order separately from Accessories. Adapter Y92F-30 for panel mounting the amplifier (optional); order separately from Accessories.			
Connections			Plated steel screw terminals (P2CF-11 and P3GA-11 sockets); Solder terminals (PL11 socket)			
Weight without socket	AC types		250 g (8.8 oz.)			
	DC types		120 g (4.2 oz.)			
Enclosure ratings	UL		—			
	NEMA		1			
	IEC 144		IP40			
Approvals	UL		—			
	CSA		—			
Ambient operating temperature			–10° to 55°C (–14° to 131°F)			
Vibration			10 to 25 Hz, 2 mm (0.08 in) double amplitude			
Shock			Approx. 10 G			

Nomenclature

■ AMPLIFIER

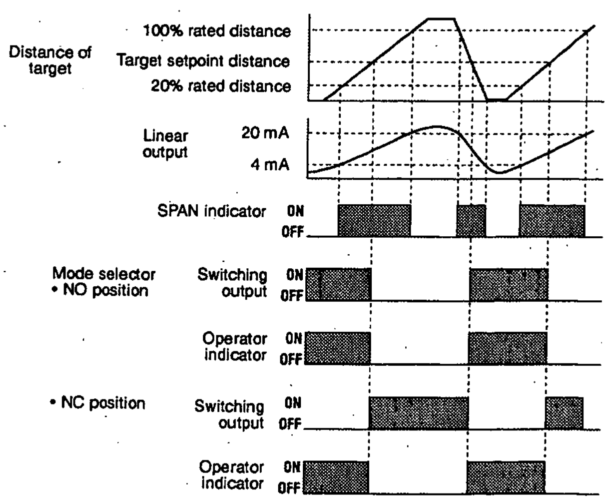


Operation

■ FUNCTION — AMPLIFIER

Classification		Function
OUTPUT	Linear output	An analog 4 to 20 mA output signal proportional to the distance from the target to the face of the sensor within the range of the 4 mA linear setpoint to the 20 mA setpoint.
	Switching output	A 100 mA, 40 VDC rated transistor output (separate power source required) adjustable within the range of the 4 mA linear setpoint and 20 mA linear setpoint.
INDICATORS	Power ON	Red LED illuminated when amplifier is connected to power source and energized.
	Operation	Red LED illuminated when the target is present within the range from the minimum sensing distance to the target setpoint distance.
	Span	Green LED illuminated when the target is present within the range of the 4 mA linear setpoint and the 20 mA linear setpoint.
ADJUSTMENTS	Cable length selector switch	Set to the length of cable (3 or 5 meters) supplied on the sensor head.
	4 mA linear adjustment	Used to set the analog output at 4 mA when the target is at 20% of the rated sensing distance. Adjustment method 1.
	20 mA linear adjustment	Used to set the analog output at 20 mA when the target is at 100% of the rated sensing distance. Adjustment method 1.
	Sensitivity	Used to set the target distance that turns on the switching output.
	Mode selector switch	Determines the logic of the switching output circuit. In the NO position, the target turns on when the target is present between the minimum sensing distance and the target setpoint distance. In the NC position, the switching output turns on when the target is beyond the target setpoint distance.

■ TIMING CHART

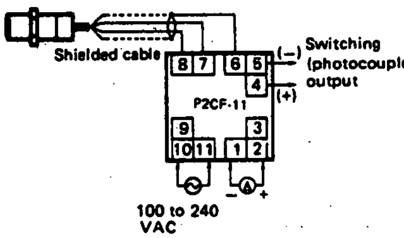


LINEAR OUTPUT ADJUSTMENTS

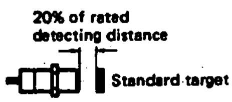
Choose one of the two adjustment methods for setting the LINEARITY adjuster. Adjustment of the 4 mA and 20 mA LINEARITY adjusters must be performed with the standard target at positions of 20% and 100% of the rated detecting distance away from the sensor.

Linearity Adjustment Method 1

1. Connect an ammeter across terminals 1 and 2. The illustration shows the sensor connected to an amplifier through socket P2CF-11.

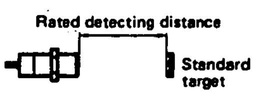


2. Place the standard target at 20% of the rated detecting distance away from the sensor unit.

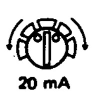


3. Turn the 4 mA LINEARITY adjuster slowly clockwise (to increase the output current) or counterclockwise (to decrease the output current). Set the adjuster to a position that reads 4 mA output on the ammeter.

4. Place the standard target at the rated detecting distance.



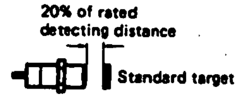
5. Turn the 20 mA LINEARITY adjuster slowly clockwise (to increase the output current) or counterclockwise (to decrease the output current). Set the adjuster to a position that reads 20 mA output on the ammeter.



6. To fine tune the adjustment accuracy of the output current, repeat the adjustment steps for 4 mA and 20 mA LINEARITY adjusters.

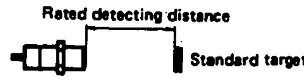
Linearity Adjustment Method 2

1. Set the standard target at 20% of the rated detecting distance away from the sensor.



2. Turn the 4 mA LINEARITY adjuster counterclockwise so that the SPAN indicator remains OFF. Then slowly turn the adjuster clockwise until the indicator illuminates. Stop turning the adjuster at the position where the SPAN indicator illuminates.

3. Set the standard target at the rated detecting distance away from the sensor.



4. Slowly turn the 20 mA LINEARITY adjuster clockwise until the SPAN indicator goes OFF. Then turn the adjuster counterclockwise until the indicator illuminates. Stop turning the adjuster when the SPAN indicator illuminates.

SENSITIVITY ADJUSTMENTS

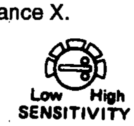
Place the standard target at the specified position. If the target moves in parallel with the surface of the sensor unit, make the adjustment after determining the position using the following procedure.

1. Adjust the linear output according to Adjustment Method 1 or 2.

2. Calculate detecting distance X using the following formula:

$$X = \frac{S}{0.8} \qquad S = \text{setting distance}$$

3. Adjust the distance between the sensor and the object to be detected to distance X.



Slowly turn the SENSITIVITY adjuster clockwise (toward HIGH) and stop turning when the OPER. indicator illuminates. Move the target to confirm that the OPER. indicator illuminates when the object to be detected is at the specified position and that the indicator goes OFF when the target is moved away from that position.

If the target moves in parallel with the surface of the sensor unit, place the sensor at distance S.

SELECTOR SWITCHES

Selection of Operation Modes

OUTPUT NO ■ NC	The output transistor turns ON when the target is detected.
OUTPUT NO ■ NC	The output transistor turns ON when the target is not being detected.

Compensation for Different Cable Lengths

Set the CABLE selector switch to the required position according to the length of the sensor cable being used: 3 m (9.8 ft) or 5 m (16.4 ft).

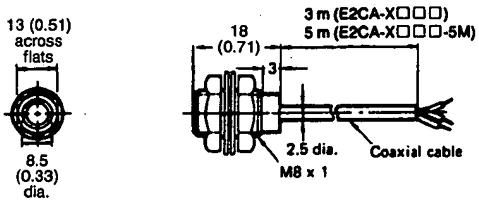
CABLE 3 m ■ 5 m	To use sensors with 3 m (9.8 ft) cable length.
CABLE 3 m ■ 5 m	To use sensors with 5 m (16.4 ft) cable length.

Dimensions

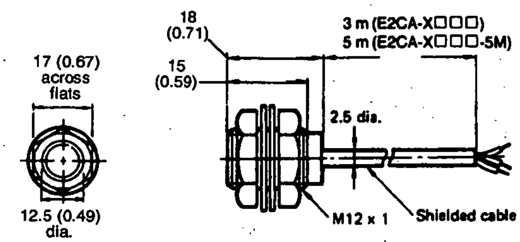
Unit: mm (inch)

SENSORS

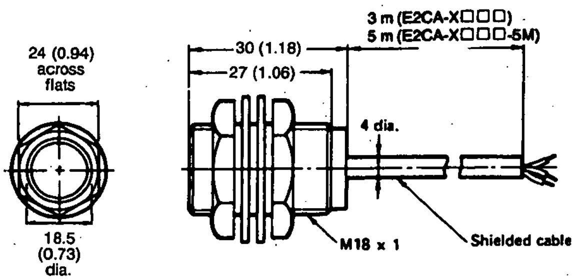
M8 Size
E2CA-X1R5A, E2CA-X1R5A-5M



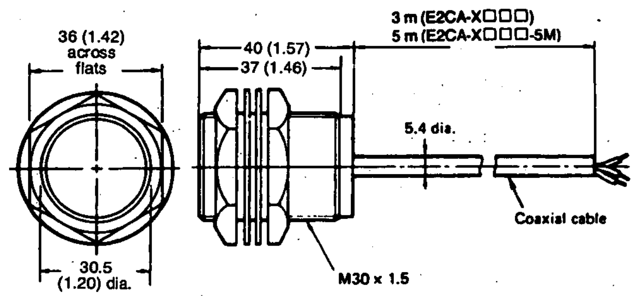
M12 Size
E2CA-X2A, E2CA-X2A-5M



M18 Size
E2CA-X5A, E2CA-X5A-5M

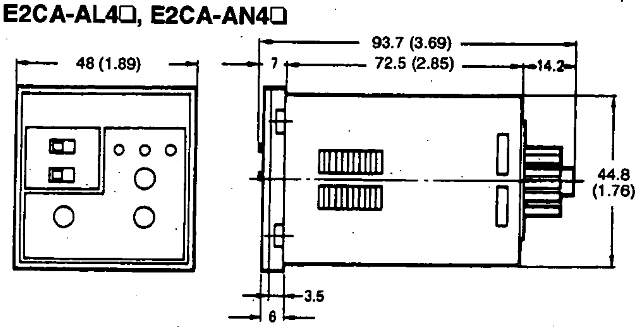


M30 Size
E2CA-X10A, E2CA-X10A-5M



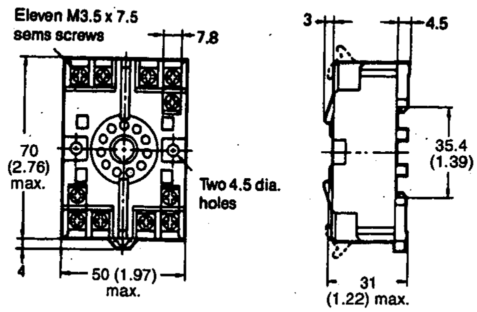
AMPLIFIERS

E2CA-AL4□, E2CA-AN4□

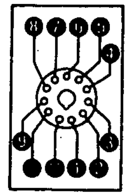


SOCKETS FOR AMPLIFIERS

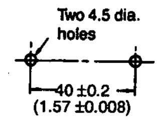
P2CF-11 Track-Mount Socket with Screw Terminals



Terminal Arrangement (top view)

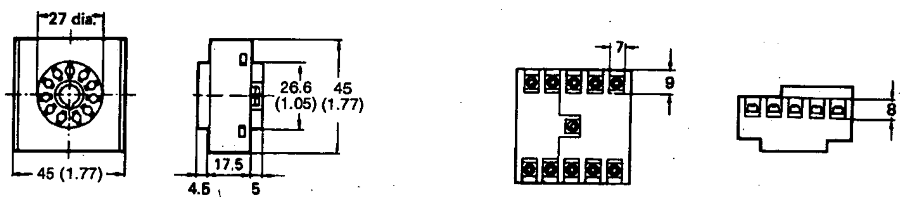


Mounting Holes

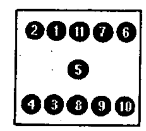


Note: The socket can be mounted on DIN rail track or surface mounted using two through holes.

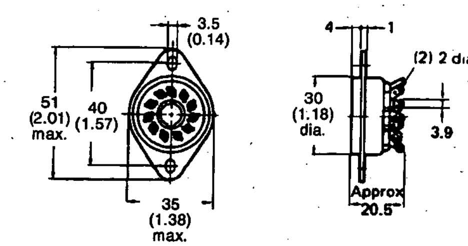
P3GA-11 Back-Mounting Socket with Screw Terminals



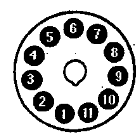
Terminal Arrangement (bottom view)



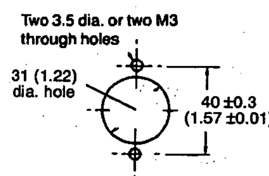
PL11 Circuit Board Socket with Solder Terminals



Terminal Arrangement (bottom view)

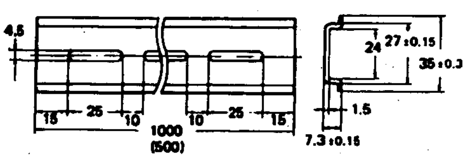


Mounting Holes

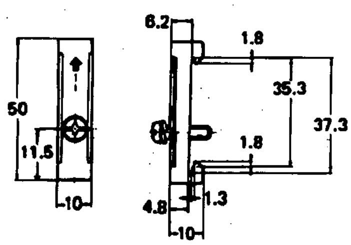


MOUNTING TRACK AND ACCESSORIES

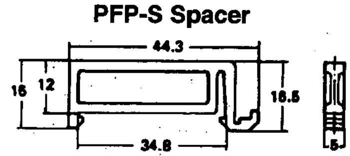
PFP-100N/PFP-50N DIN Rail Track



PFP-M End Plate

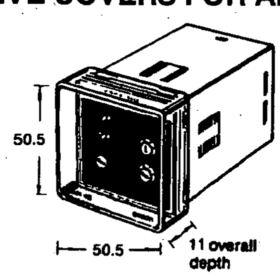


PFP-S Spacer

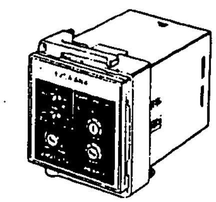


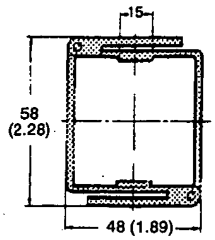
Y92A-48, Y92A-48D OPTIONAL PROTECTIVE COVERS FOR AMPLIFIERS

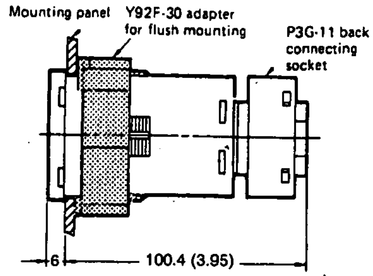
Hard plastic cover Y92-48 and soft plastic cover Y92A-48D snap onto the front of the amplifier to protect it from dust, dirt and water drip. The Y92A-48 hard plastic cover projects 4 mm from the front of the amplifier. Y92A-48D soft plastic cover fits snugly over the front.



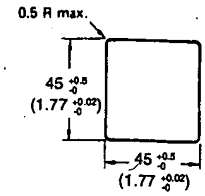
Y92F-30 OPTIONAL PANEL MOUNTING ADAPTER FOR AMPLIFIERS





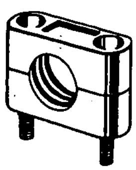


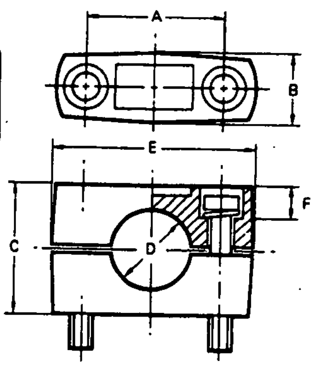
Panel cutout



Note: Recommended panel thickness is 1 to 3.2 mm.

OPTIONAL MOUNTING BRACKETS FOR SENSORS



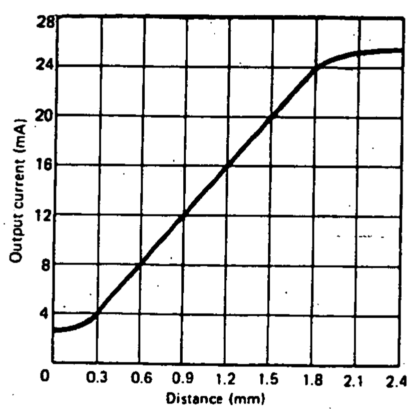


Part number	Drawing dimension						Applicable sensor models
	A	B	C	D	E	F	
Y92E-B8	18±0.2	10 max.	18	8 dia.	28 max.	M4 x 20 bolt	E2CA-X1R5A, E2CA-X1R5A-5M
Y92E-B12	24±0.2	12.5 max.	20	12 dia.	37 max.	M4 x 25 bolt	E2CA-X2A, E2CA-X2A-5M
Y92E-B18	32±0.2	17 max.	30	18 dia.	47 max.	M5 x 32 bolt	E2CA-X5A, E2CA-X5A-5M
Y92E-B30	45±0.2	17 max.	50	30 dia.	60 max.	M5 x 50 bolt	E2CA-X10A, E2CA-X10A-5M

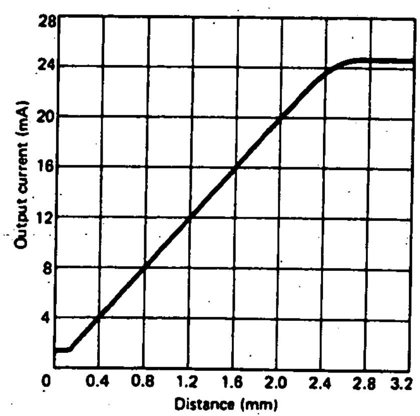
Engineering Data

OPERATING DISTANCE VS. OUTPUT CURRENT

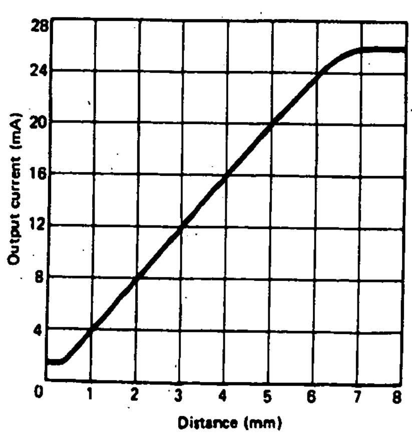
M8 Size Sensor
E2CA-X1R5A



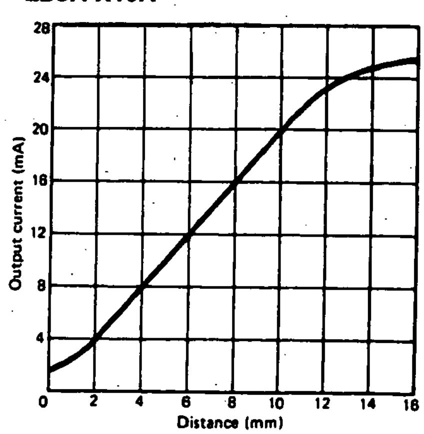
M12 Size Sensor
E2CA-X2A



M18 Size Sensor
E2CA-X5A

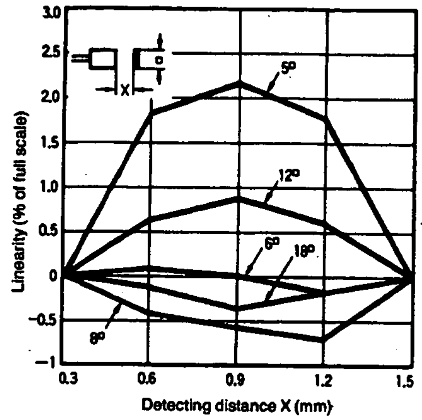


M30 Size Sensor
E2CA-X10A

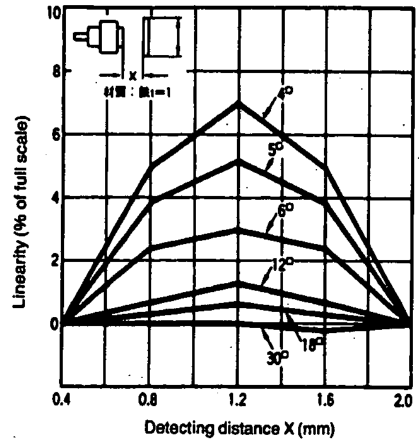


■ DETECTING DISTANCE VS. LINEARITY (SQUARE AND RECTANGULAR OBJECTS)

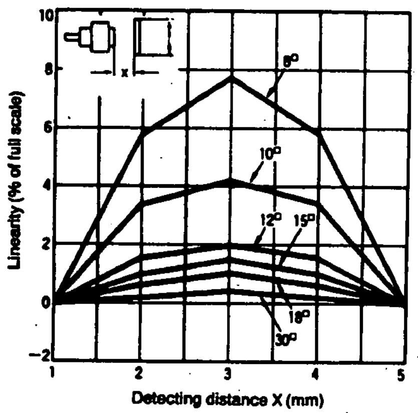
M8 Size Sensor
E2CA-X1R5A



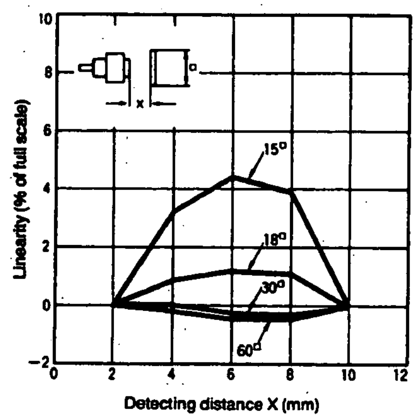
M12 Size Sensor
E2CA-X2A



M18 Size Sensor
E2CA-X5A

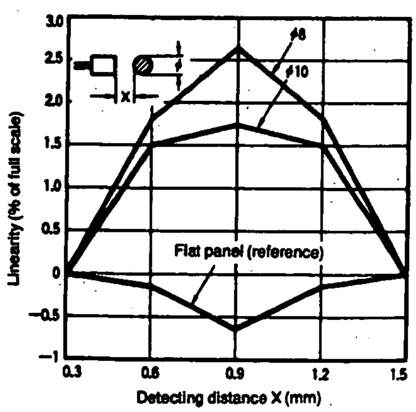


M30 Size Sensor
E2CA-X10A

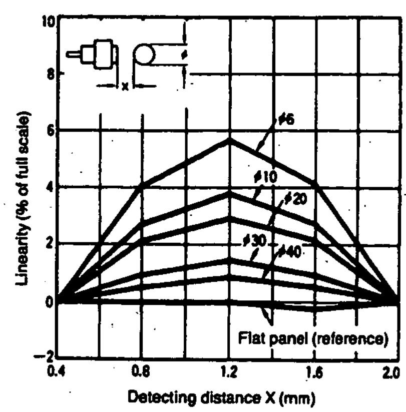


■ DETECTING DISTANCE VS. LINEARITY (CYLINDRICAL OBJECTS)

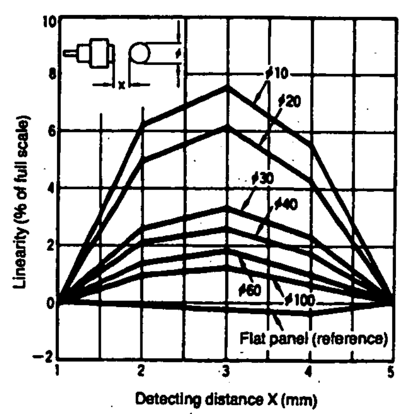
M8 Size Sensor
E2CA-X1R5A



M12 Size Sensor
E2CA-X2A

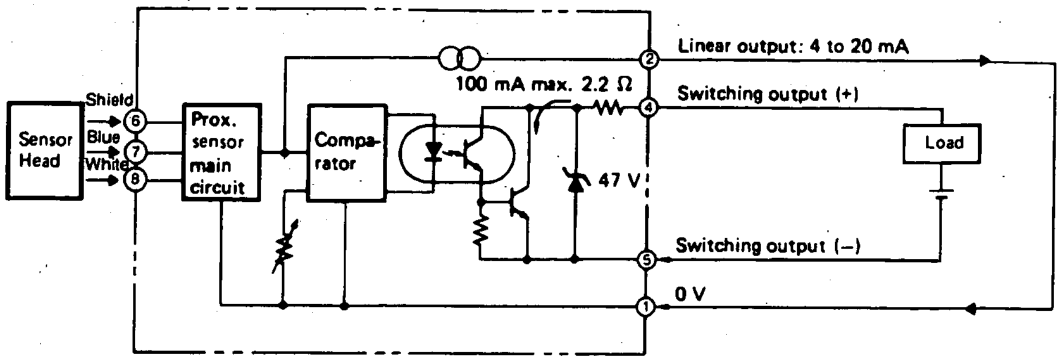


M18 Size Sensor
E2CA-X5A



Installation

■ OUTPUT CIRCUIT DIAGRAM

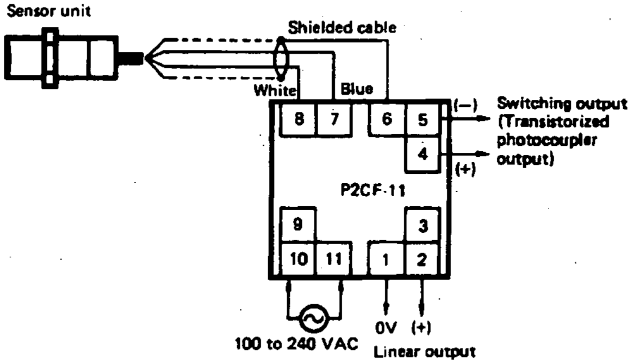


E2CA-A□4□ Amplifier

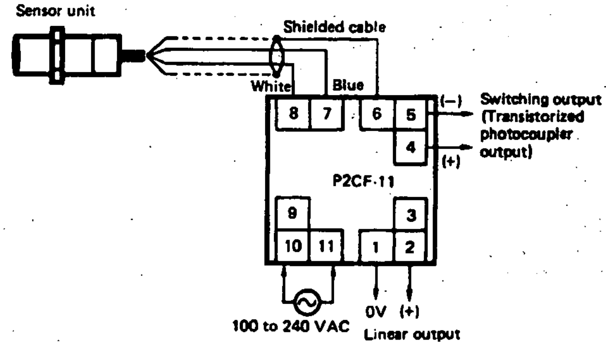
■ CONNECTIONS BETWEEN SENSOR AND AMPLIFIER

Note: The illustrations show the terminal arrangement viewed from the rear of the socket that is coupled to the amplifier.

DC Amplifier and Sensor

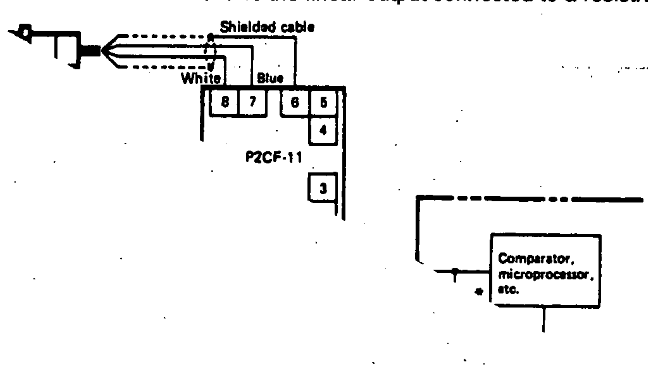


AC Amplifier and Sensor



■ CONNECTION OF LINEAR OUTPUT

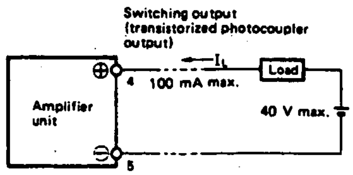
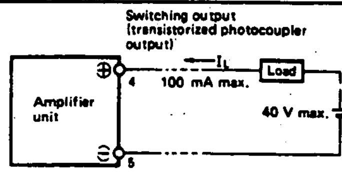
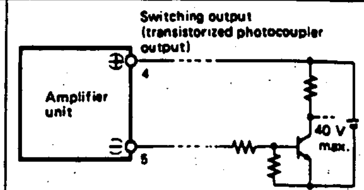
Note: The illustration shows the linear output connected to a resistive load.



* Resistance R when E2CA-AL4 is used: 300 Ω max. at 24 V/150 Ω max. at 12 V
Resistance R when E2CA-AN4 is used: 300 Ω max.

■ CONNECTION OF SWITCHING OUTPUT

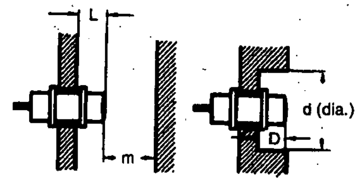
A transistorized photocoupler output is used for the switching output of the E2CA-A☐4☐ amplifier unit, which offers flexibility for switching different loads and power supply polarity selection.

Type of load	Direct load drive: Relay or solenoid	Solid-state load	
		Sink load (photocoupler)	Voltage load (logic circuit)
E2CA-A☐4☐ amplifiers		 With a source load, connect the load to the negative terminal for transistorized photocoupler output.	

■ MOUNTING SENSORS

Effects of Surrounding Metals

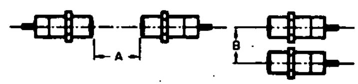
Shielded E2CA proximity sensors may be mounted flush with a metallic panel. Be sure to provide a minimum distance as shown in the table to prevent the sensor from being affected by metallic objects other than the target.



Drawing dimension	Sensor model							
	E2CA-X1R5A		E2CA-X2A		E2CA-X5A		E2CA-X10A	
	mm	inch	mm	inch	mm	inch	mm	inch
L	0	0	0	0	0	0	0	0
d (dia.)	8	0.32	12	0.47	18	0.71	30	1.18
D	0	0	0	0	0	0	0	0
m	4.5	0.18	6	0.24	15	0.59	30	1.18

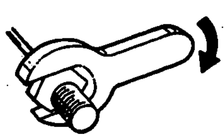
Mutual Interference

To prevent mutual interference between two sensors, be sure to space the two sensors at a distance greater than that shown in the table.



Drawing dimension	Sensor model							
	E2CA-X1R5A		E2CA-X2A		E2CA-X5A		E2CA-X10A	
	mm	inch	mm	inch	mm	inch	mm	inch
A	20	0.79	30	1.18	50	1.97	100	3.94
B	15	0.59	20	0.79	35	1.38	70	2.76

Tightening Force



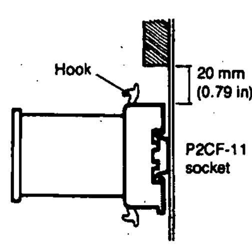
Do not exceed the maximum torque listed in the table.

Sensor model	Maximum torque	
	kg-cm	in-lbs
E2CA-X1R5A	20	17
E2CA-X2A	60	52
E2CA-X5A	150	130
E2CA-X10A	400	346

■ MOUNTING AMPLIFIERS

Track-Mount Installation Using P2CF-11 Socket

The P2CF-11 socket has two hooks that secure the E2CA amplifier to the socket. Be sure to allow at least 20 mm (0.79 in) clearance above and below the socket to gain access and to release the hooks for servicing and maintenance. The P2CF-11 socket may also be used for surface mounting the amplifier using the two through holes.



Panel-Mount Installation Using Y92F-30 Adapter and P3GA-11 Socket

Insert the E2CA amplifier through the panel cutout. Push the Y92F-30 adapter from the rear of the amplifier as far forward toward the panel as possible. Then tighten the two retaining screws. Wire the P3GA-11 socket, then push it onto the rear of the amplifier. To release the adapter, lift the tab at the rear of the adapter.

Several E2CA amplifiers may be panel mounted close together using Y92F-30 adapter as shown here. When mounting two or more amplifiers in a vertical line, arrange the adapters so that their molded tabs are positioned on the right and left sides. When mounting two or more amplifiers in a horizontal line, arrange the adapters so that their molded tabs are positioned on the top and bottom sides.

Panel Cutout for Side-by-Side Mounting of Two Amplifiers

NOTE: DIMENSIONS ARE SHOWN IN MILLIMETERS. To convert millimeters to inches divide by 25.4.

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